THERMAL COAGULATION POINT OF BLOOD AND SERUM *

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It has been definitely demonstrated that certain infectious diseases can be transmitted by a filtrable virus. That is, the infectious agent of these diseases is so small that it can pass through a Berkefeld filter. Among the diseases of this type are poliomyelitis, hog cholera, foot and mouth disease, and mosaic disease of tobacco.

Since the Berkefeld filter will not remove the virus of certain infectious diseases from serum, it becomes necessary to obtain some other means of sterilization. The simplest as well as the most efficient means at our disposal is heat. If we can apply sufficient heat to a product without changing its composition, we have an ideal method of sterilization.

Fortunately, many of the filtrable viruses are destroyed at a comparatively low temperature, that is, at a temperature below the coagulation point of serum. It is possible, therefore, to heat serums to a point sufficient to destroy many of the filtrable viruses without destroying the antibodies or potency of the serums.

The question directly leading up to this discussion is the possibility of the spread of foot and mouth disease by means of hog cholera serum. At least 1 outbreak of foot and mouth disease has been attributed to infected hog cholera serum. It has been found that hog cholera serum can be heated sufficiently to destroy foot and mouth disease virus, which might be present, without apparently changing the physical properties or the potency of the serum. It is important in heating serums to know at what point coagulation will occur, so that this temperature may not be too nearly approximated or the danger point reached.

With this end in view, 67 samples of blood and serums from different animals were heated at varying temperatures, to determine the lowest coagulation point. The heating was carried on in test tubes in a water bath. Each sample was heated for 1 hour. The hog blood

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freshly drawn was defibrinated, and the whole blood heated without the addition of a preservative. A portion of the defibrinated blood was centrifuged and the clear serum was heated without the addition of phenol or tricresol. To another part of the defibrinated blood 1% extract of the navy bean was added to agglutinate the red corpuscles.

TABLE 1

RESULTS OF THE HEATING OF HOG BLOOD AND HOG SERUM

	56 C.	57 C.	58 C.	59 C.	60 C.	61 C.	62 C.	63 C.	64 C.	65 C.
Hog Blood Defibrinated										
1	—	—	+	+	++					
2	—	—	+	+	++					
3	—	—	—	+	++					
4	—	—	—	+	++					
5	—	—	+	++						
6	—	—	+	+	++					
Hog Serum, without Preservative										
7	—	—	—	—	—	—	—	—	+	++
8	—	—	—	—	—	—	—	+	++	
9	—	—	—	—	—	—	—	—	++	
10	—	—	—	—	—	—	—	—	+	++
11	—	—	—	—	—	—	—	—	+	++
12	—	—	—	—	—	—	—	+	++	
13	—	—	—	—	—	—	—	+	++	
14	—	—	—	—	—	—	—	+	++	
Hog Serum with 1% Bean Extract										
15	—	—	—	—	—	—	—	—	++	
16	—	—	—	—	—	—	—	—	++	
17	—	—	—	—	—	—	—	+	++	
18	—	—	—	—	—	—	—	+	++	
19	—	—	—	—	—	—	—	—	+	++
20	—	—	—	—	—	—	—	—	++	
21	—	—	—	—	—	—	—	—	+	++
22	—	—	—	—	—	—	—	—	—	++
23	—	—	—	—	—	—	—	—	+	++
24	—	—	—	—	—	—	—	+	++	
25	—	—	—	—	—	—	—	—	+	++
26	—	—	—	—	—	—	—	—	—	++

— means no change; + means viscid, increased surface tension; ++ means complete coagulation.

This was then centrifuged in the usual way and the clear serum heated. Table 1 gives the results of the heating of hog blood and hog serum.

It is to be seen from Table 1 that defibrinated hog blood without preservative became viscid in all 6 samples at 58 C., that 1 sample coagulated at 59 C., and that 5 samples coagulated at 60 C.

Hog serum, without preservative, became viscid in 4 samples at 63 C., was coagulated in 5 samples at 64 C., and in 3 samples at 65 C.

Hog serum with 1% bean extract became viscid in 3 samples at 63 C., was coagulated in 6 samples at 64 C., and in 6 samples at 65 C.

In addition to the heating as is shown in Table 1, 12 samples of defibrinated hog blood were heated for 10 hours at 50 C. The blood turned darker in color, but there was no coagulation nor apparent change otherwise.

In order to determine the effect of phenol on the coagulation point, 0.5% phenol was added to 3 samples of defibrinated hog blood, and to 4 samples of hog serum. The defibrinated phenolized blood coagulated at 56 C., and the phenolized serum, at 60 C.

Serum and antitoxin for human and veterinary use are produced from various animals. If we depend entirely on the filtration of a serum for sterility, there is a bare possibility of transmitting some filtrable virus disease through a supposedly harmless serum. This is especially true in the case of transfusion and in the use of human serum. If the filtration process is supplemented by heating the serum, a safer product is obtained.

In order to determine how much heat might be safely applied to serums from various animals, it was decided to test several samples from each of the most commonly used serums.

Serums from horse, sheep, calf, rabbit, guinea-pig, and man were heated to determine the coagulation point. The serum from each animal was prepared by defibrinating the blood mechanically and by centrifuging to remove the corpuscles. The clear serum was used without the addition of any preservative. Each sample was heated for 1 hour in a water bath. Table 2 shows the results of this heating.

Six samples of horse serum were heated; 5 coagulated at 63 C., 1, at 64 C.

All 6 samples of sheep serum coagulated at 65 C. This was to be expected, since all 6 samples were taken from the same sheep at different times. The different samples from the other animals were taken from separate animals.

Calf serum coagulated in 3 samples at 66 C., in 3 others, at 67 C.

Rabbit serum coagulated in 1 sample at 69 C., in 3 samples at 70 C.; 1 sample was viscid but not coagulated at 70 C.

The coagulation point of guinea-pig serum varied from 65 C. to 67 C. Three samples coagulated at 65 C., 4 at 66 C., and 1 at 67 C.

TABLE 2

RESULTS OF THE HEATING OF HORSE, SHEEP, CALF, RABBIT, GUINEA-PIG AND HUMAN

	60 C.	61 C.	62 C.	63 C.	64 C.	65 C.	66 C.	67 C.	68 C.	69 C.	70 C.
Horse Serum											
27	—	—	—	++							
28	—	—	—	++							
29	—	—	—	++							
30	—	—	—	++							
31	—	—	—	++							
32	—	—	—	+	++						
Sheep Serum											
33	—	—	—	—	—	++					
34	—	—	—	—	+	++					
35	—	—	—	—	+	++					
36	—	—	—	—	—	++					
37	—	—	—	—	—	++					
38	—	—	—	—	+	++					
Calf Serum											
39	—	—	—	—	—	—	++				
40	—	—	—	—	—	—	+	++			
41	—	—	—	—	—	—	+	++			
42	—	—	—	—	—	—	++				
43	—	—	—	—	—	—	—	++			
44	—	—	—	—	—	—	++				
Rabbit Serum											
45	—	—	—	—	—	—	—	—	—	++	
46	—	—	—	—	—	—	—	—	—	+	++
47	—	—	—	—	—	—	—	—	—	—	++
48	—	—	—	—	—	—	—	—	—	+	++
49	—	—	—	—	—	—	—	—	—	—	+
Guinea-pig Serum											
50	—	—	—	—	—	—	++				
51	—	—	—	—	—	—	+	++			
52	—	—	—	—	—	++					
53	—	—	—	—	—	—	++				
54	—	—	—	—	—	++					
55	—	—	—	—	—	++					
56	—	—	—	—	—	+	++				
57	—	—	—	—	—	—	++				
Human Serum											
58	—	—	—	—	++						
59	—	—	—	—	++						
60	—	—	—	—	+	++					
61	—	—	—	++							
62	—	—	—	—	++						
63	—	—	—	—	++						
64	—	—	—	—	++						
65	—	—	—	—	++						
66	—	—	—	—	+	++					
67	—	—	—	—	—	++					

— means no change; + means viscid, increased surface tension; ++ means complete coagulation.

Human serum showed some slight variation. One sample coagulated at 63 C., 6 samples at 64 C., and 3 samples at 65 C.

SUMMARY

Defibrinated hog blood was heated for 10 hours at 50 C., without coagulation.

Defibrinated hog blood became viscid at 58 C., and coagulated at 60 C.

Defibrinated hog blood with 0.5% phenol coagulated at 56 C.

Hog serum, without preservative, became viscid at 63 C., coagulated at 64 and 65 C.

The addition of 1% bean extract to hog serum did not affect the coagulation point.

The addition of 0.5% phenol to blood or serum gave a marked reduction in the coagulation point.

Horse serum coagulated at 63 and 64 C.

Sheep serum coagulated at 65 C.

Calf serum coagulated at 66 and 67 C.

Rabbit serum coagulated at 69 and 70 C.

Guinea-pig serum coagulated at 65, 66, and 67 C.

Human serum coagulated at 63, 64, and 65 C.